K-5 Science Curriculum Analysis Worksheet

Current research on science education emphasizes the importance of integrating the learning progressions from all three dimensions included in *A Framework for K-12 Science Education.* This Curriculum Analysis Worksheet is a tool that can be used to align your current instructional practices to a 3-dimensional model of instruction, designed to deepen student learning.

1.	Identify a science concept or concepts within the Arizona Science Standard from Strands 4, 5, or 6 that you teach at your grade level/course. Fill in the title of the science concept at the top of the worksheet.
2.	Identify learning progressions from each of the three dimensions that will be bundled together to build student conceptual understanding of the science concept(s) selected in Step 1.
3.	a. Identify objectives from the Arizona Science Standard from Strands 1, 2 and 3 that align with the **Science and Engineering Practices** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
4.	a. Identify the current objectives from the Arizona Science Standard from Strands 4, 5, and 6 that align with the **Disciplinary Core Ideas** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
5.	a. Identify the current unifying concept(s) from page viii of the Arizona Science Standard that aligns with the **Crosscutting Concepts** learning progression(s) you have identified in Step 2. b. Examine your current science curriculum to identify ways you can modify instruction to reach the vision of *A Framework for K-12 Science Education* while you currently teach grade level objectives aligned to the Arizona Science Standard.
6.	a. Identify connections to grade level ELA/Literacy standards, as appropriate. b. Identify connections to grade level Mathematics standards and practices, as appropriate.

1. Arizona Science Concept: Strand 6 Concept 2: Earth's Processes and Systems

Big Idea/Scientific Phenomenon: The composition of the Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate.

- Earth's surface features (landscapes) change over time.

2. Science and Engineering Practices Learning Progression *(See Learning Progressions for K-5 Science)*	**Disciplinary Core Ideas Learning Progression** *(See Learning Progressions for K-5 Science)*	**Crosscutting Concepts Learning Progression** *(See Learning Progressions for K-5 Science)*
Planning and Carrying Out Investigations • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. **Analyzing and Interpreting Data** • Analyze and interpret data to make sense of phenomena using logical reasoning. • Use data to evaluate and refine design solutions. **Constructing Explanations and Designing Solutions** • Identify the evidence that supports particular points in an explanation. • Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	**ESS2: Earth Systems** • Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. • Human activities affect Earth's systems and their interactions at its surface **ESS3: Earth and Human Activity** • A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. **ETS1: Engineering Design** • Testing a solution involves investigating how well it performs under a range of likely conditions.	**Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. **ETS2: Links among Engineering, Technology, and Applications of Science** • Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.

Three Dimensional Learning Outcomes:

- Gather data (experimentally or through research) to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind or vegetation.
- Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

3. Science and Engineering Practices

Current Practice

Identify performance objectives from Strands 1-3 within the Arizona Science Standard that align to the learning progressions listed above.
(Strand 1: Inquiry; Strand 2: History and Nature of Science; Strand 3: Science and Social Perspectives)
STRAND 1

Concept 1: Observations, Questions, and Hypotheses
Observe, ask questions, and make predictions.
PO 2. Formulate a relevant question through observations that can be tested by an investigation.
PO 3. Formulate predictions in the realm of science based on observed cause and effect relationships.
PO 4. Locate information (e.g., book, article, website) related to an investigation.

Concept 2: Scientific Testing (Investigating and Modeling)
Participate in planning and conducting investigations, and recording data.
PO 1. Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.
PO 2. Plan a simple investigation that identifies the variables to be controlled.
PO 3. Conduct controlled investigations (e.g., related to erosion) in Earth and space sciences.
PO 4. Measure using appropriate tools and units of measure.
PO 5. Record data in an organized and appropriate format.

Concept 3: Analysis and Conclusions
Organize and analyze data; compare to predictions.
PO 1. Analyze data obtained in a scientific investigation to identify trends.
PO 2. Formulate conclusions based upon identified trends in data.
PO 3. Determine that data collected is consistent with the formulated question.
PO 4. Determine whether the data supports the prediction for an investigation.
PO 5. Develop new questions and predictions based upon the data collected in the investigation.

Concept 4: Communication
Communicate results of investigations.
PO 1. Communicate verbally or in writing the results of an inquiry.
PO 3. Communicate with other groups or individuals to compare the results of a common investigation.

Strand 3 Concept 2: Science and Technology in Society
Understand the impact of technology.
PO 3. Design and construct a technological solution to a common problem or need using common materials.

Vision of A Framework for K-12 Science Education

Gap Analysis/Curriculum Examination
Refer to the Science and Engineering practice learning progressions within the Learning Progressions for K-5 Science document and your current curriculum to answer the following questions.

- What practices are currently missing from my curriculum?
- What changes and refinements need to be made?
- What strategies/investigations can be implemented to achieve the vision?

Engage:
Provide before and after pictures of areas where landscapes have changed due to water or wind (Colorado River in the Grand Canyon, fallen arches, sea arches/bridges, rock formations, etc.) to generate student discussion and ideas about what could cause the change.

Explore:
Set up stations for students to be able to compare and contrast effects of various types of erosion (chemical, water, wind, glacier), and other processes (weathering, deposition) that can change landscape features.

Set up stream tables (or similar) for students to test variables on the rate of erosion and deposition (variables could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow, etc.)

Explain:
Use the data collected from each station and stream table experiments to provide an evidence-based explanation (Claim-Evidence-Reasoning) of how water and wind can change landscapes. Use the evidence and reasoning to explain the phenomena shown in the before and after pictures.

Extend with Engineering design:

- Research the role of engineers in protecting the environment, landmark structures, and/or people from the effects of erosion and weathering.
- Use the engineering design cycle to develop, test, and refine a solution to minimize the effects of erosion (under classroom testable conditions).

4. Disciplinary Core Ideas

Current Performance Objectives

AZ Strand 6 Concept 2: Earth's Processes and Systems

Understand the processes acting on the Earth and their interaction with the Earth systems.

PO 1. Identify the Earth processes that cause erosion.
PO 2. Describe how currents and wind cause erosion and land changes.
PO 3. Describe the role that water plays in the following processes that alter the Earth's surface features:
- erosion
- deposition
- weathering

PO 4. Compare rapid and slow processes that change the Earth's surface, including:
- rapid –floods
- slow – wind, weathering

Strand 3 Concept 1: Changes in Environments

Describe the interactions between human populations, natural hazards, and the environment.

PO 1. Describe how natural events and human activities have positive and negative impacts on environments (e.g., fire, floods, pollution, dams).
PO 2. Evaluate the consequences of environmental occurrences that happen either rapidly (e.g., fire, flood, tornado) or over a long period of time (e.g., drought, melting ice caps, the greenhouse effect, erosion).

Strand 3 Concept 2: Science and Technology in Society

Understand the impact of technology.

PO 3. Design and construct a technological solution to a common problem or need using common materials.

Vision of *A Framework for K-12 Science Education*

Gap Analysis

Refer to the Content learning progressions within the Learning Progressions for K-5 Science document and your current curriculum to answer the following questions.

- What core idea(s) is/are currently targeted within my current curriculum?
- What changes and refinements need to be made? (add, refine, delete concepts)
- What strategies/investigations can be implemented to achieve the vision?

1. With each station, provide investigation that builds understanding of each process (erosion, deposition, and weathering)
2. Provide informational text (including illustrations) that explains each process (erosion, deposition, weathering) help students deepen their understanding and build academic and domain-specific vocabulary.
   - Example: Erosion tradebook by Virginia Castleman
3. Before moving to stream table investigation, give students an opportunity to discuss findings and ideas from each of the stations.
4. Demonstrate how to use the stream tables.
5. After students have practice, let them investigate their own questions. How can they change one variable at a time? What variable will they change? (not all students test the same variables) What do the results tell them about how water can change the landscape?
6. Students develop an explanation (C-E-R) of how water and wind can change landscapes.
7. Provide video, picture or text that shows impact of natural events that change landscapes.
8. Have students describe positive and/or negative effects, based on the information provided.
9. Have students identify one negative effect and then use the engineering design cycle to find a solution that can reduce the impact of the negative effect (based on classroom constraints).

5. Crosscutting Concepts

Current Crosscutting Concepts

Unifying Concepts and Processes (Crosscutting concepts)
Listed in page viii of the front matter of the Arizona Science Standard, and explained in the National Science Education Standards (1995) pp. 115-119

Evidence, Models, and Explanation

Constancy, Change, and Measurement

Vision of *A Framework for K-12 Science Education*

Gap Analysis
Refer to the Crosscutting Concepts learning progressions within the Learning Progressions for K-5 Science document and your current curriculum to answer the following questions.

- How is/are the crosscutting concept(s) made explicit within my current curriculum?
- What changes and refinements need to be made?
- What strategies/investigations can be implemented to achieve the vision?

Cause and Effect
Provide opportunities to test causal relationships and use these relationships to explain change (if water carries soil away from one area, it will deposit it in a different area; if weathering cracks a large rock, chunks of the rock will eventually break off and fall).

Stability and Change
Provide opportunities for students to see change in terms of differences over time: students compare processes that occur over large periods of time (such as wind erosion forming arches) to processes that occur over short periods of time (effects of flash flooding) and observe that change may occur at different rates. Students learn some systems appear stable, but over long periods of time they will eventually change.

Connections to Engineering, Technology, and Applications of Science
Provide opportunities for students to understand how engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.

6. Connections			
Other Content Area Standards	**Identify other Content Area Standards that will build student understanding of this concept or phenomenon, especially those in ELA/Literacy and Mathematics/Practices.** **RI.4.7** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. **RI.4.9** Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. **W.4.7** Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. **W.4.8** Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. **W.4.9** Draw evidence from literary or informational texts to support analysis, reflection, and research. **SL.4.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts,* building on others' ideas and expressing their own clearly.	**Connections to Instruction**	**Gap Analysis** **Refer to the Other content standards that are being used as a connection to answer the following questions.** • How are the connected standards explicitly taught within my current curriculum? • What changes and refinements need to be made? • What strategies/investigations can be implemented to achieve the vision? **Reading** Provide trade books or other texts for students to use to build understanding at each of the investigation stations. **Writing** Students display data collected in appropriate ways, and explain how the information provides evidence to support their claim. Students write explanations to explain how water and wind can change landscapes very quickly or over long periods of time. **Speaking and Listening** Students participate in small group and class discussions to answer questions about how wind and water shape landscapes.